RESEARCH CONCERNING SCARIFICATION INFLUENCE ON SOIL FERTILITY AND AGRICULTURAL PRODUCTION ON SLOPES

CERCETĂRI PRIVIND INFLUENȚA SCARIFICĂRII ASUPRA FERTILITĂȚII SOLULUI ȘI PRODUCȚIEI AGRICOLE PE TERENURI ÎN PANTĂ

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Abstract. *Soil compaction on slopes leads to worsening of aeration regime, reducing water capacity and permeability of the soil and also to increased loss of water from surface runoff. As an effective method of soil loosening can be scarification. In the literature there are no arguments for parameters that vary depending on soil texture, landscape and crop. This paper provides farmers experimentally reasoned knowledge about the frequency of scarification, the distance between cracks and its depth.*
Key words: *crop yield, scarification, soil fertility, water conservation.*

Rezumat. *Tasarea solului pe pante conduce la înrăutățirea regimului de aerație, micșorarea capacității și permeabilității pentru apă a solului și totodată conduce la majorarea pierderilor de apă din precipitații și scurgerile de suprafață. Ca procedeu eficient de afânare a solului poate servi scarificarea. Actualmente în literatura de specialitate nu sunt argumentați parametrii ce variază în dependență de textura solului, relief și cultură. Prezenta lucrare pune la dispoziție agricultorilor cunoștințe argumentate experimental despre periodicitatea de scarificare, distanța între fisuri și adâncimea ultimei.*
Cuvinte cheie: *fertilitate, recolta, scarificarea, umiditatea solului.*

INTRODUCTION

Erosion is the main factor of soil degradation on slopes (Krupenikov, 2004). The harmful effects of the erosion are: decrease of soil fertility and crop production, worsening of hydric regime, increase of drought effect etc. An important role for runoff decrease and erosion reduction on agricultural lands has soil scarification. It contributes to water conservation in soil, maintaining of a good physical soil state and, at the same time, reduces fuel consumption. The main purpose of our research was elaboration of optimal technologic parameters for scarification of eroded arable soils. The next objectives were achieved: 1. Assessment of the effectiveness of different periodicity of scarification; 2. Determination of necessary scarification depth; 3. Argumentation of optimal distance between the fissures. The article describes modifications of properties of moderately eroded ordinary chernozem from the South part of Republic of Moldova after the scarification.

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MATERIAL AND METHOD

It is well known that scarification is an efficient method of soil loosening (Dumitrescu, 1979; Stancu, 2005; Douglas, 2006; Alincăi, 2007). But in literature there are no experimentally based arguments for such parameters as optimal periodicity, depth and distance between the fissures for scarification, that will evidently vary depending on soil texture, relief and temperature. According to that, in autumn 2001 at the experimental station of Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo", Ursoaia village, Cahul district, three experiments were founded (figure 1 A). The experiments were set up on moderately eroded ordinary chernozems on a slope 5-7° with northeast exposition.

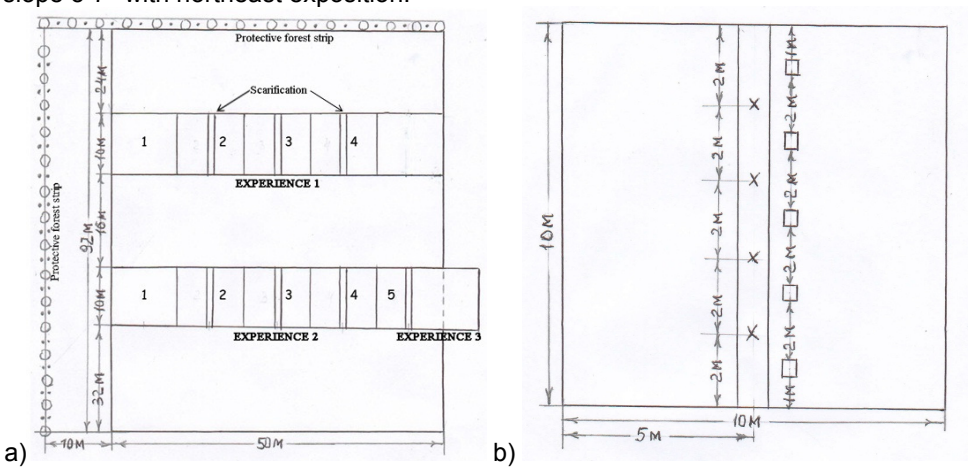

Fig. 1 - A) Experiences location scheme; B) Experience scheme: x - soil sample points; □ – crop yield sample points

Each experimental variant contains two fissures at a depth of 40 cm oriented across the slope (figure 1 B). The experimental plots are 10 m long. Between the pairs of fissures four soil sample points are set up. Among this sample points and 1 m downhill the fissures, in five points was made crop accounting (experience 1).

Assessment of the effect of scarification periodicity was made through determination of water reserves in soil annually in March, bulk density, total porosity, humus content, mobile forms of phosphorus and potassium and crop yields. Annually chemical fertilizers ($N_{60}P_{30}$) were applied. Scheme of the second experience, length of experimental plots and distance between them, soil and crop yield sample points are similar to the first experiment (figure 1 A). In the second experiment scarification was made once during the foundation. In the next years (year 2, 3, 4) it was determined the length of post action of scarification at different depth. Estimation of scarification optimal depth was made through determination of the same indices as from the first experiment. Annually in spring chemical fertilizers ($N_{60}P_{30}$) were applied. Estimation of the optimal distance between the fissures was made through determination of water reserves accumulated in 0-100 cm of soil at different distances downhill the fissures.

RESULTS AND DISCUSSIONS

The research results revealed that scarification of moderately eroded ordinary chernozems had a benefic influence on soil total water reserves (table 1)

Table 1

Influence of scarification on total water reserves (m^3/ha) in 0-100 cm layer depending on different parameters

Variant / Crop, year	Winter barley	Maize	Sunflower	Winter wheat
Experience 1. Determination of scarification optimal periodicity of eroded soils				
1) Control plot (20 cm tillage)	2153	2124	2186	2167
2) Annual scarification	2344	2327	2402	2388
3) Scarification once in 2 years	2336	2318	2378	2382
4) Scarification once in 3 years	2227	2210	2279	2243
5) Scarification once in 4 years	2221	2196	2270	2238
Experience 2. Determination of scarification optimal depth of eroded soils				
1) Control plot (20 cm tillage)	2354	2291	2443	2172
2) Scarification at 20 cm	2473	2373	2552	2266
3) Scarification at 40 cm	2578	2495	2666	2381
4) Scarification at 60 cm	2597	2510	2680	2400
Experience 2. Determination of optimal distance between the pairs of fissures				
1) Control plot (20 cm tillage)	2339	2178	2277	2196
2) 1 m from the scarification line	2573	2419	2504	2400
3) 2 m from the scarification line	2556	2411	2488	2393
4) 3 m from the scarification line	2434	2282	2360	2290
5) 4 m from the scarification line	2427	2269	2355	2271

In comparison with the control plot, periodic scarification contributed to additional water accumulation in 0-100 cm layer. The reserves were higher by 68-191 m^3/ha at winter barley, 72-203 m^3/ha at maize, 84-216 m^3/ha at sunflower and 72-221 m^3/ha at winter wheat. The best results were obtained on variants with annual scarification and once in two years at all crops with similar results. The best effect of water accumulation was obtained on variants with scarification made at a depth 40 cm and 60 cm. The values of water reserves here are approximately identical. The highest values of water reserves in 0-100 cm layer were obtained at scarification with distance between the fissures 1-2 m that was considered optimal. Laboratory analysis revealed some changes of physical and chemical properties in tilled layer as well as in the underlying layers after periodic scarification (table 2).

Soil bulk density varies between 1,18 and 1,26 g/cm^3. The lowest values were obtained at the scarification once in two years where a sharp increase was established (1,18 g/cm^3). At the same time total porosity increased to 55,1% in comparison with control plot (52,6%). It was established an increase of humus content and nutritive elements in soil in conditions of scarification with best results at annual scarification and once in two years.

Table 2

Influence of periodic scarification on physical and chemical properties of moderately eroded ordinary chernozems, 2002-2005

Depth, cm	Bulk density, g/cm^3	Porosity, %	Humus content, %	P_2O_5	K_2O
				mg/100 g soil	
Control plot (20 cm tillage)					
0-20	1,26	52,6	2,29	1,44	16,1
20-40	1,34	49,4	1,47	0,99	14,3
40-60	1,35	49,6	0,89	0,47	13,2
Annual scarification					
0-20	1,22	53,8	2,52	2,47	20,4
20-40	1,26	52,6	1,64	1,71	18,3
40-60	1,29	50,4	1,12	1,02	15,1
Scarification once in 2 years					
0-20	1,18	55,1	2,51	2,43	21,7
20-40	1,22	53,8	1,62	1,69	17,8
40-60	1,27	51,0	1,10	0,81	14,2
Scarification once in 3 years					
0-20	1,25	52,3	2,41	1,98	18,3
20-40	1,33	49,6	1,53	1,36	15,4
40-60	1,34	49,4	0,93	0,75	14,8
Scarification once in 4 years					
0-20	1,26	52,4	2,39	1,81	17,9
20-40	1,35	49,6	1,51	1,30	15,9
40-60	1,35	50,0	0,91	0,66	14,4

Some significant changes were established in moderately eroded ordinary chernozems in dependence of scarification depth (table 3).

Table 3

Influence of scarification depth on physical and chemical properties of moderately eroded ordinary chernozems, 2002-2005

Depth, cm	Bulk density, g/cm^3	Porosity, %	Humus content, %	P_2O_5	K_2O
				mg/100 g soil	
Control plot (20 cm tillage)					
0-20	1,29	50,4	2,27	1,42	15,9
20-40	1,34	49,4	1,49	0,98	14,1
40-60	1,37	46,7	0,93	0,51	12,8
Scarification at 20 cm					
0-20	1,30	49,6	2,37	1,84	17,2
20-40	1,34	49,4	2,56	1,35	15,0
40-60	1,36	47,2	1,02	0,69	13,2
Scarification at 40 cm					
0-20	1,19	54,4	2,61	2,49	20,8
20-40	1,23	53,0	1,68	1,76	18,1
40-60	1,29	50,4	1,20	1,07	15,9
Scarification at 60 cm					
0-20	1,22	53,8	2,64	2,51	21,1
20-40	1,26	52,6	1,73	1,84	18,4
40-60	1,27	51,0	1,21	1,12	16,1

The lowest values of bulk density were registered in arable layer at scarification depth 40 cm and 60 cm (1,19 and 1,22 g/cm^3). Total porosity increased up to 53,8 and 54,4%. In this conditions it was established an increase of humus content and nutritive elements respectively: 0,33 and 0,37%, 1,07 and 1,09 mg/100 g soil, 5,2 and 5,9 mg/100 g soil. In both layer this values are almost identical.

The influence of deep scarification on crop production was determined. It was established that periodic scarification increased crop yield of winter barley by 242-449 kg/ha (17-32%) in comparison with control plot (table 4).

Table 4

Influence of periodic scarification on crop production on moderately eroded ordinary chernozems, 2002-2005

Variant	Crop production		
	kg/ha	%	Crop increase
Winter barley, 2002			
1) Control plot (20 cm tillage)	1412	100	-
2) Annual scarification	1861	132	449
3) Scarification once in 2 years	1843	131	431
4) Scarification once in 3 years	1701	121	289
5) Scarification once in 4 years	1654	117	242
LSD (The Least Significant Difference) 0,5% - 317			
Maize, 2003			
1) Control plot (20 cm tillage)	3312	100	-
2) Annual scarification	3700	112	388
3) Scarification once in 2 years	3669	111	357
4) Scarification once in 3 years	3569	108	257
5) Scarification once in 4 years	3487	105	175
LSD 0,5%	273		
Sunflower, 2004			
1) Control plot (20 cm tillage)	1214	100	-
2) Annual scarification	1546	127	332
3) Scarification once in 2 years	1528	126	314
4) Scarification once in 3 years	1397	115	183
5) Scarification once in 4 years	1355	112	141
LSD 0,5%	204		
Winter wheat, 2005			
1) Control plot (20 cm tillage)	1324	100	-
2) Annual scarification	1713	129	389
3) Scarification once in 2 years	1681	127	357
4) Scarification once in 3 years	1440	109	116
5) Scarification once in 4 years	1415	108	91
LSD 0,5%	152		

The research results revealed that the highest crop yields were achieved at scarification at a depth of 40 cm and 60 cm (table 5). Crop increase of winter barley was 400 and 425 kg/ha, maize 342 and 374 kg/ha, sunflower 314 and 329 kg/ha, winter wheat 391 and 469 kg/ha.

Table 5

Average crop yields at different scarification depth on moderately eroded ordinary chernozems, 2002-2005

Variant	Crop production		
	kg/ha	%	Crop increase
Winter barley, 2002			
1) Control plot (20 cm tillage)	1397	100	-
2) Scarification at 20 cm	1507	108	110
3) Scarification at 40 cm	1798	129	401
4) Scarification at 60 cm	1822	130	425
LSD 0,5%	203		
Maize, 2003			
1) Control plot (20 cm tillage)	3289	100	-
2) Scarification at 20 cm	3428	104	139
3) Scarification at 40 cm	3631	110	342
4) Scarification at 60 cm	3663	111	374
LSD 0,5%	178		
Sunflower, 2004			
1) Control plot (20 cm tillage)	1199	100	-
2) Scarification at 20 cm	1318	110	119
3) Scarification at 40 cm	1513	126	314
4) Scarification at 60 cm	1528	127	329
LSD 0,5%	238		
Winter wheat, 2005			
1) Control plot (20 cm tillage)	1301	100	-
2) Scarification at 20 cm	1398	107	97
3) Scarification at 40 cm	1692	130	391
4) Scarification at 60 cm	1770	136	469
LSD 0,5%	259		

CONCLUSIONS

1. Scarification influences the majority of soil properties located on slopes increasing its fertility and crop productivity.

2. We recommend performing scarification of soil on slopes once in two years at a depth of 40-50 cm with distance between the fissures 1-2 m.

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